X. *On some eggs of Hemiptera.* By David Sharp, M.A., M.B., F.R.S., &c.

[Read May 11th, 1892.]

Plates VIII. & IX.

The remarkable examples of the eggs of insects I am about to describe were procured by the late Mr. Neville Goodman, of Cambridge, in the Valley of the Amazons. Mr. Goodman made a journey to that locality in the year 1879, being accompanied by his son Roger, and remained there from Sept. 26th to the end of December; during which time he formed, with the assistance of his son, an interesting collection of various orders of insects. After the decease of Mr. Goodman, his son, Mr. Roger Goodman, M.A., presented this collection to the University of Cambridge; and, on taking possession of the collection for preservation in the University Museum, my attention was attracted by a small object of a somewhat unusual nature.

The specimen had the appearance of a small wasp attached by the wings to a mass on a leaf, and on the wings of the wasp where it was attached were a number of small insects crowded together indiscriminately. On a closer examination it was seen that these small insects consisted of a number of two species of *Ichneumonidæ*, and some minute creatures that appeared to be made of legs and antennæ; these latter, on more careful comparison, were seen to be specimens of some species of Hemiptera-Heteroptera, just hatched from the egg, and with the abdomen quite shrivelled up.

The glimpse I could obtain of the central mass was very imperfect, but, as it seemed to be a cluster of insect eggs of a very unusual nature, I felt desirous of making further acquaintance with it; and, foreseeing that in so doing I should necessarily derange the natural position of the various parts of the specimen, I before doing so placed it in the hands of Mr. E. Wilson, who made of it

the very good sketch from which fig. 1, Plate VIII., is taken.

On removing some of the superincumbent small insects, the central mass could be partly seen, and it could be noticed that it consisted of a densely packed mass of columnar bodies, probably about one hundred in number. A portion of this mass is seen in fig. 2, Plate VIII.

The fact that some of the small insects were newly-hatched Hemiptera suggested that this mass of columnar bodies might be the eggs from which the bugs had emerged, but if so, they were clearly eggs of a most peculiar nature, for they consisted of two tiers or stories, and moreover, attached to the mass, there were some peculiar bodies having more the appearance of the styles and stigma of a flower than of anything I was acquainted with in the insect world.

In order to get a better view of the object the wings of the wasp were displaced so that the upper surface was displayed, and a still more curious and problematic set of structures was revealed; for it was seen that the upper extremity of each egg of the two external series presented the appearance of a capsular body with an orifice in the middle, while the eggs in the centre had their free tops split up into ligulæ, and some of these latter were curled over, and were seen to embrace the peculiar floral-like structures I have already mentioned. Fig. 3 gives a view of a portion of the upper surface of the mass.

I then sent some of the small Hymenoptera to Mr. Peter Cameron, who was kind enough to inform me that they consisted of two species of the genus *Telenomus*, known to hymenopterologists as inquilines in the eggs of bugs. Mr. Cameron has since described them under the names of *T. melanogaster* and *T. amazonica* (Mem. Manchester Soc. 1891).

The probability that the columnar objects were the eggs of a bug was much increased by this fact, and became certainty on my observing that from the upper surfaces of several of the objects the young bugs were actually projecting, having, in fact, been killed, and arrested in the act of emerging from the egg. A few of the eggs were then detached from the mass, and submitted to examination to ascertain their structure; and

on this being done, it appeared that each egg was an object similar to that of which a longitudinal section is shown in fig. 4, Plate IX.

Each egg is, in fact, a cylinder divided into two tiers, the lower of which is about two-thirds of the whole length, and is the egg proper; while the upper tier is a capsule containing the peculiar floral object. This capsule and its contents are of so remarkable a nature, and their functions are so problematical, that I think it advisable to describe their structure, so far as I have been able to observe it. The capsule is somewhat constricted in the middle, and the orifice at the top (fig. 4, *o*) forms the entrance to a dependent tube, which hangs down nearly as far as the middle of the length of the capsule.

The structure contained in the capsule I will call the cone; a section of it is shown in fig. 5, Plate IX. It is a quite hard structure of almost glassy consistency; it is not regularly conical in form, but is more like a truncated cone surmounted by a spike; from the sides of the part where the truncation occurs there extends a delicate lace-work structure, becoming divergent as it ascends, and coming into contact with the sides of the capsule, with which, indeed, the delicate lace-work is almost certainly continuous.

The chamber occupying the lower part of the cylinder is the egg proper, in which the embryo is developed. In fig. 6 is explained the way in which the insect emerges; the embryo, pushing upwards, lifts the cone contained in the superior capsule, whose point, as we have seen, projects into the dependent tube of the capsule, and the capsule is thus ruptured, as exhibited in *b*, fig. 6; the embryo, continuing to ascend, the cone is pushed out of the capsule (*c*, fig. 6), and falls away, and the insect then emerges, leaving the empty egg-shell, as shown in *d*, fig. 6.

The bunch of eggs, of which I am writing, had been killed by Mr. Goodman at exactly the right moment for allowing us to understand this process of emergence, the various stages of the act being displayed on different parts of this example.

The parasitic Hymenoptera had also just emerged; the holes they had made for this purpose are displayed at the lower part of fig. 2, and above them are seen some

of the cones that have fallen out from the capsules, and have adhered to the sticky substance with which the whole of the outer surface of the egg-mass is smeared; the lower part of the mass being very thickly plastered with such substance.

The fact that the two outer series of eggs are intact as to their capsules is explained by the presence of the destroying Hymenoptera, the mothers of these having been able to place their eggs only in the two series of the hemipterous eggs next the outside, the others being protected by their more internal position in the closely-packed mass; the tops of the eggs are, of course, protected by the capsules and the cones contained therein, and the lower faces of the eggs by the leaf on which the mass is placed, so that only the outer two layers of the bugs' eggs have been within reach of the ovipositor of the female Hymenoptera.

We have seen that there are two species of these hymenopterous destroyers; perhaps one may have a longer ovipositor than the other, and so be able to reach the second row of eggs; or it may be that the two rows of eggs are pierced indiscriminately by each of the two destroying species.

We have thus accounted for the presence of the bugs and of the Hymenoptera in this curious entomological specimen, but we have not alluded to the large wasp depicted in fig. 1, and we cannot but feel some curiosity to know what part this has played in the drama. Of course this should be settled by actual observation. The presence of the wasp may be purely fortuitous; it may have become accidentally entangled in the sticky mass, and have been unable to disentangle itself. But this method of accounting for its presence does not appear at all probable, for, as will be observed on reference to fig. 1, the wasp is reposing on one side, and is attached by the tip of one wing to the lower part of the mass on which the adhesive matter I have alluded to is so abundantly placed; and, as its position does not look like one into which it could have got by means of accidental entanglement, I incline rather to the supposition that the wasp was stuck in its position by the parent bug as a meal for its future offspring when they should be hatched. This supposition is supported not only by the position of the wasp, but also by some other facts, *viz.*:

—1, that the bug is of a carnivorous nature (belonging, doubtless, to the *Reduviidæ*, though the species is not known); 2, that the newly-hatched bugs are mere skeletons, apparently almost all external organisation, with the abdomen destitute of any contents, so that they would be urgently in need of a supply of food; and 3, the fact that the wasp has a slit made on the back of its thorax, so that the young bugs could plunge their rostra without any difficulty into the interior of the wasp.

The Reduviid bugs have some of them the power of inflicting a wound that has a very numbing effect. It might well be, then, that the wasp was mastered by the parent bug, who split the wasp's thorax with its rostrum, benumbed it by the same process, and then attached it to the egg-mass as a store of food to start the newly-hatched young bugs on their journey through life. This, however, is purely supposition, though I hope it may be some day confirmed by the observation of a naturalist who shall be so happy as to have the opportunity of watching the habits of Reduviid bugs in the Amazon Valley.

But the chief interest in these bugs' eggs is connected with the peculiar capsule and its contained cone, and we cannot but ask what can be the function of this beautiful and complex structure. The answer that would be given by those who are acquainted with Leuckart's paper "On the Micropyle, and the minute structure of the Egg-shell in Insect's Eggs" (Müller's Arch. f. Anat. Phys., 1855), would be that it is a micropyle-apparatus of the most complex and perfect character; and on the whole I am inclined to believe that this solution, extraordinary as it may seem to be, is likely to prove, at any rate, partially correct; but it must be admitted that there is considerable doubt about it, and that some other purpose is also served by the structure.

A micropyle is a canal through an egg-shell, by which the entry of a spermatozoon to the egg is facilitated; nothing can be simpler than that arrangement, and one does not see any reason why it should be departed from to give place to an extraordinarily large and complex apparatus that the spermatozoon must traverse before arriving at its destination. The capsule and the cone contained in it are no doubt fabricated in the

ovarian passages of the mother, and, on looking at our figures, it must appear a mystery how such a structure as is there represented can facilitate the entry of one or more spermatozoa to the egg, while the structure is passing through the maternal oviduct.

Leuckart, who is almost our sole source of information as to structures of this nature, has figured, in a rough manner, a number of eggs of bugs, *l. c.*, pl. viii., ff. 1—26. These exhibit a great variety of structures at the upper pole of the egg, but only one at all resembles our Amazonian egg in the mechanical arrangement of the apparatus; the resemblance, however, so far as one can judge, is but a distant one. The egg in question (f. 16, pl. viii.) is that of *Phytocoris viridis*.

Leuckart has not, however, given such an account of the intimate structure of the egg as would allow any valuable opinion to be formed as to the functions of the part he roughly figures, and he remained himself in doubt on this point, as will be seen by a passage on p. 149, *t. c.*, where he says:—"I do not know how to give any satisfactory conclusion as to the meaning of this wonderful apparatus: that its object should be to open (or unfold) the cover seems scarcely credible; one would, indeed, much rather suppose that it served as a support to the cover, especially as this latter is only very loosely inserted. Meanwhile, it remains doubtful whether the sole function of this structure consists in this."

A brief account of the structure of the capsule and its contents, in the case of the Amazonian Reduviid, is therefore desirable; but there is considerable difficulty attending the examination of these eggs after they have been long dried, and covered as they are externally by a gummy matter. The form of the capsule will be perceived by reference to the section shown in fig. 4; the wall of the capsule (fig. 4*c* and fig. 8*b*) is a piece of lacework, the meshes of which are completely filled up by some other substance, reminding one of what exists in dried leaves or husks of some seeds. The walls of this capsule are apparently impervious, and the only means of entrance to the interior of the capsule is by the dependent tubule at the summit.

The "cone" in the interior of the capsule is shown in section in fig. 5; it apparently consists of a series of

closely-packed tubes, some of which extend from the sides of the spike at the summit to the base of the cone, while others open at the sides of the cone, but apparently also communicate with the shallow chamber at the base of the cone; this chamber, *c* of fig. 5, is closed in below by a peculiar transparent plate, having the appearance of a piece of mica; this plate, though itself quite impervious, is so transparent that it allows the meshwork of the surface above it to be seen, as shown in fig. 7. From the point at which the cone is narrowed or truncated there extends outwards a beautiful transparent lace-work of rather larger meshes; this lace-work becomes more delicate as it diverges, and is perhaps, at its termination, actually continuous with the mesh-work of the inner wall of the capsule. The whole of the system of canals in the cone apparently converges to the chamber *c*, fig. 5; in the figure in question the section of this chamber is shown to be limited by a wall on each side, but I am very doubtful whether that wall (*d*) really exists; I think it will ultimately prove that the transparent plate (*m*), forming the floor of the cone, is not really part of the cone, but is a peculiarly developed part of the inner membrane of the egg, and that the cone is merely loosely set on this, and that the two, though lifted up together by the emerging insect, have no actual continuity.

Supposing the cone to be a system of tubes giving entrance to air or other matter, then this substance will have to find its way into the interior of the egg proper by a gap or system of canals extending round the egg on the inside of the capsule at the spot marked *f* in fig. 4. Now it is at this spot, judging from what I have observed in the egg of another bug, *Piezosternum subulatum*, and from the figures of Leuckart, *t. c.*, pl. viii., ff. 6, 14, &c., that I should expect the true micropyle canals to exist; it seems, therefore, quite possible that, though distinct from the true micropyles, the cone may be a means of communicating with them.

In the absence of any direct observation, it is useless to indulge in further speculation on what the function of these wonderful cones may be; it seems in the highest degree improbable that they can be simple in their function, possessing as they do so great a development, and it is more probable that they serve two or even three

purposes. That the peculiar capsule and its contents can be looked on as mere evolutions of the simple micropyle is almost impossible, unless some very peculiar or complex function is subserved by them.

Some time ago I exhibited the egg of another bug to this Society (*cf.* Proc. Ent. Soc., 1889, p. i). This egg is also of a very peculiar character; it possesses at one end a series of circumferential projections like small nails partially driven in; and also a peculiar flask-like structure in the middle, and quite isolated from the nail-like bodies; these latter are, I have no doubt, micropyles, as I have been able to see the canal extending through one or two of them to the interior of the egg. What the middle flask-like object may be I am unable to say, but I think it quite probable that its function may be partially the same as the capsule and cone of the Amazonian Reduviid; the wall of the flask representing the wall of the Reduviid capsule, and a substance that can be dimly perceived within the flask-wall seated at its base being, perhaps, similar in its function to the cone of the Reduviid bug. Fig. 9, Plate VIII., represents this egg of *Piezosternum subulatum*, *a* being the nail-like objects, and *b* the flask-like structure.

Explanation of Plates VIII. & IX.

Figs. 1 to 8 relate to the eggs of a Reduviid bug of unknown species, and fig. 9 to the egg of *Piezosternum subulatum* (*Pentatomidæ*).

Fig. 1, Plate VIII.—Sketch of the egg-mass of Reduviid hemipteron with wasp adherent to it by the wings, and with a crowd of parasitic *Proctotrupidæ* and newly-emerged Reduviids.

Fig. 2, Plate VIII.—Portion of the same egg-mass, showing the two outer circles of eggs, from which Hymenoptera have emerged at the holes marked *h*; *a*, egg situated near the centre, in which a bug is beginning the process of emergence by lifting a cone; *c*, cones that have fallen from eggs during the process of emergence, and become entangled in the sticky substance with which the eggs are covered.

Fig. 3, Plate VIII.—Portion of the same egg-mass, showing, *a*, eggs with capsules ruptured by the process of emergence of the

young bugs; *b*, the capsules intact (the interior of the egg having been eaten by Hymenoptera).

Fig. 4, Plate IX.—Outline of one egg, seen in partial section (the capsule, *c*, being divided, and a portion of the lattice-work broken away); *a*, the cone surmounted by its spine projecting into the entrance-tube, *o*, of the capsule; *b*, lace or lattice-work (partially broken away), connecting the cone with the wall of the capsule; *d*, portion of the egg in which the embryo is developed.

Fig. 5, Plate IX.—Longitudinal section of a cone, showing its tubular structure and the small transverse space below it, with which all the tubes communicate; *a*, body of the cone; *b*, lattice-work that connected it with capsule; *c*, transverse inferior space or chamber; *d*, circumferential wall of this chamber.

Fig. 6, Plate IX.—Eggs, showing the mode of emergence; *a*, egg intact, with cone in the capsule above the embryo-chamber undisturbed; *b*, the young insect commencing to emerge, and rupturing the capsule by elevation of the cone; *c*, the young insect just emerging, with cone falling away; *d*, empty egg-shell.

Fig. 7, Plate IX.—The cone and its lattice-work removed from the capsule.

Fig. 8, Plate IX.—Portion of egg at the point of contact of the various parts; *a*, wall of the embryo chamber; *b*, wall of capsule; *c*, cone in the interior of capsule.

Fig. 9, Plate VIII.—Egg of *Piezosternum subulatum* (taken from interior of body), referred to in Proc. Ent. Soc., 1889, p. 1; *a*, nail-like objects, probably micropyles; *b*, vase-like structure of unknown function.